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F3A ADN AEA

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None

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UK CL (Edition J) **B7A ATB , F3A ABB ABC ADC ADD ADN ADP AEA AEB A12**
INT CL^4 **F42B 3/00 23/18 23/20 , F42C 11/04 11/06**

(54) Method and device for remotely actuating mines

(57) In a programming phase, particular command and acknowledgement bit patterns are agreed via a monitoring- and interference-proof infrared channel with a mine 10 - 10^{IV} or a group of mines by means of a handset 18. In a command phase, the mines are armed or disarmed via a radio-frequency channel which can be monitored, during which process, however, only commands and acknowledgements previously agreed in the programming phase are accepted.

For enciphering and deciphering a command transmitted from an operating station (10, Fig 6) to a mine station (30, Fig 6) and of an acknowledgement transmitted in the reverse direction, the command bit patterns and acknowledgement bit patterns are in each case logically combined with mask bit patterns in a mask bit memory (14, 34) by means of exclusive OR gates (18, 20; 44, 46). The mine station (30) in each case keeps available two adjacently located mask bit patterns for the logical operation in order to be able to recognize the transmitted command in the case of an interference in the back channel. The mask bit patterns in the mask memories (14, 34) of the operating station (10) and of the mine station (30) are incremented upon transmission and successful reception of command data.

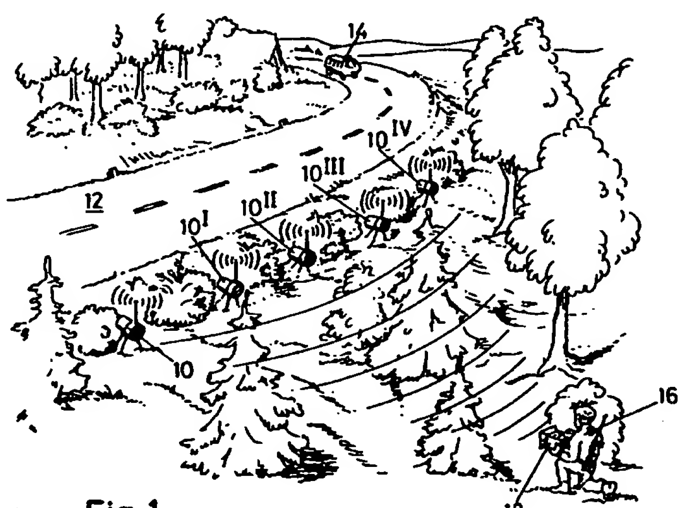

Fig. 1

GB 2 299 850 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

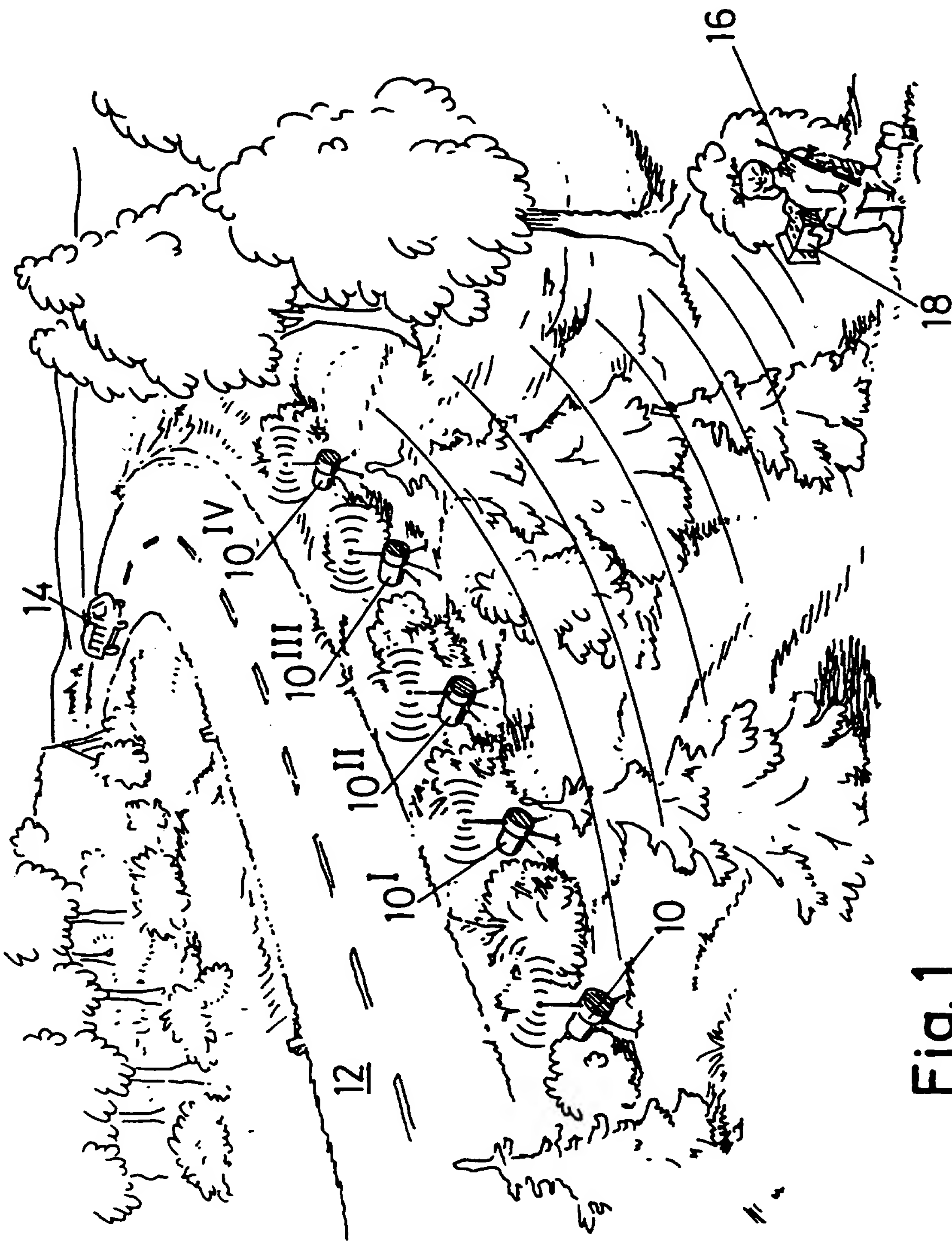

Fig. 1

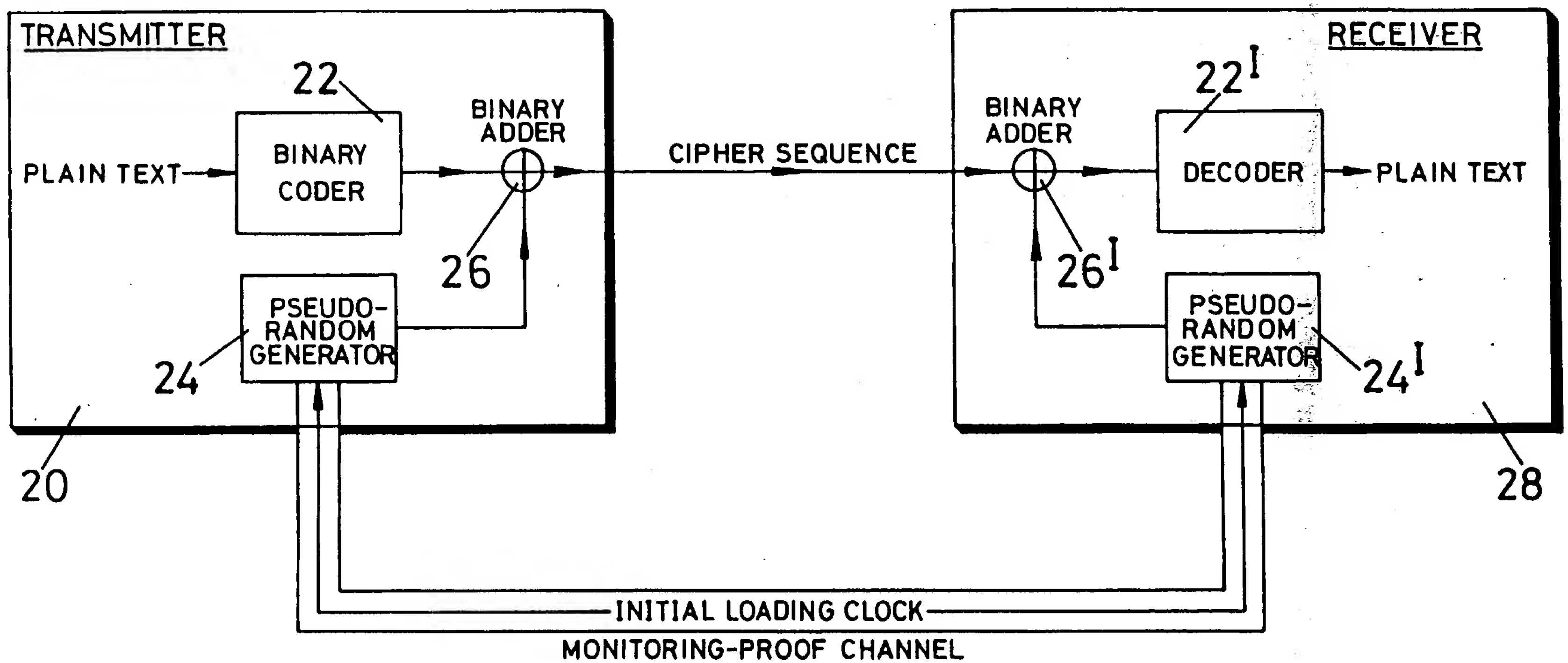
TRANSMITTER
22
PLAIN TEXT
BINARY CODER
BINARY ADDER
26
PSEUDO-RANDOM GENERATOR
24
20
CIPHER SEQUENCE
RECEIVER
22^{I}
BINARY ADDER
DECODER
PLAIN TEXT
26^{I}
PSEUDO-RANDOM GENERATOR
24^{I}
28
INITIAL LOADING CLOCK
MONITORING-PROOF CHANNEL

Fig. 2

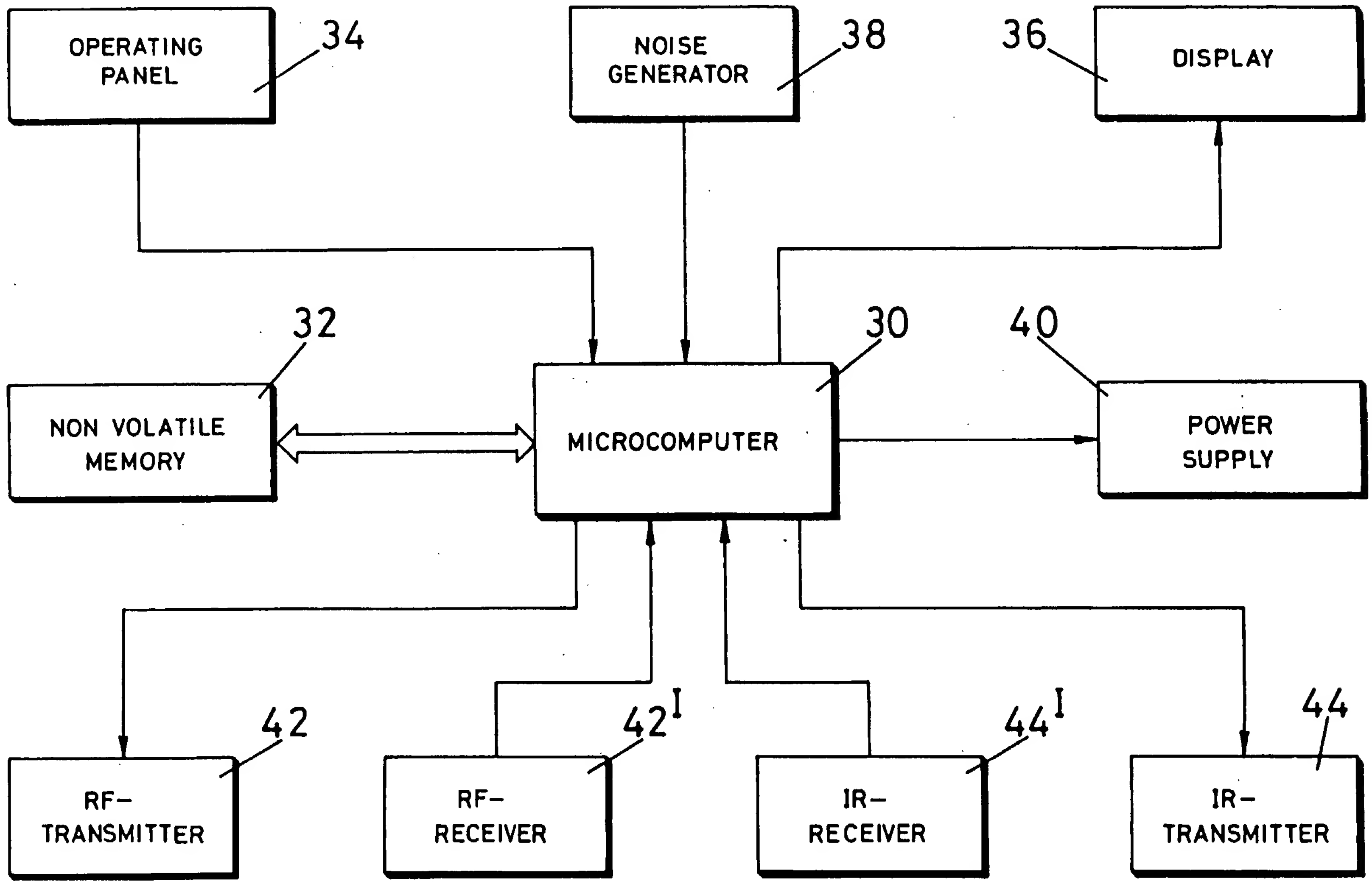

Fig. 3

handset components

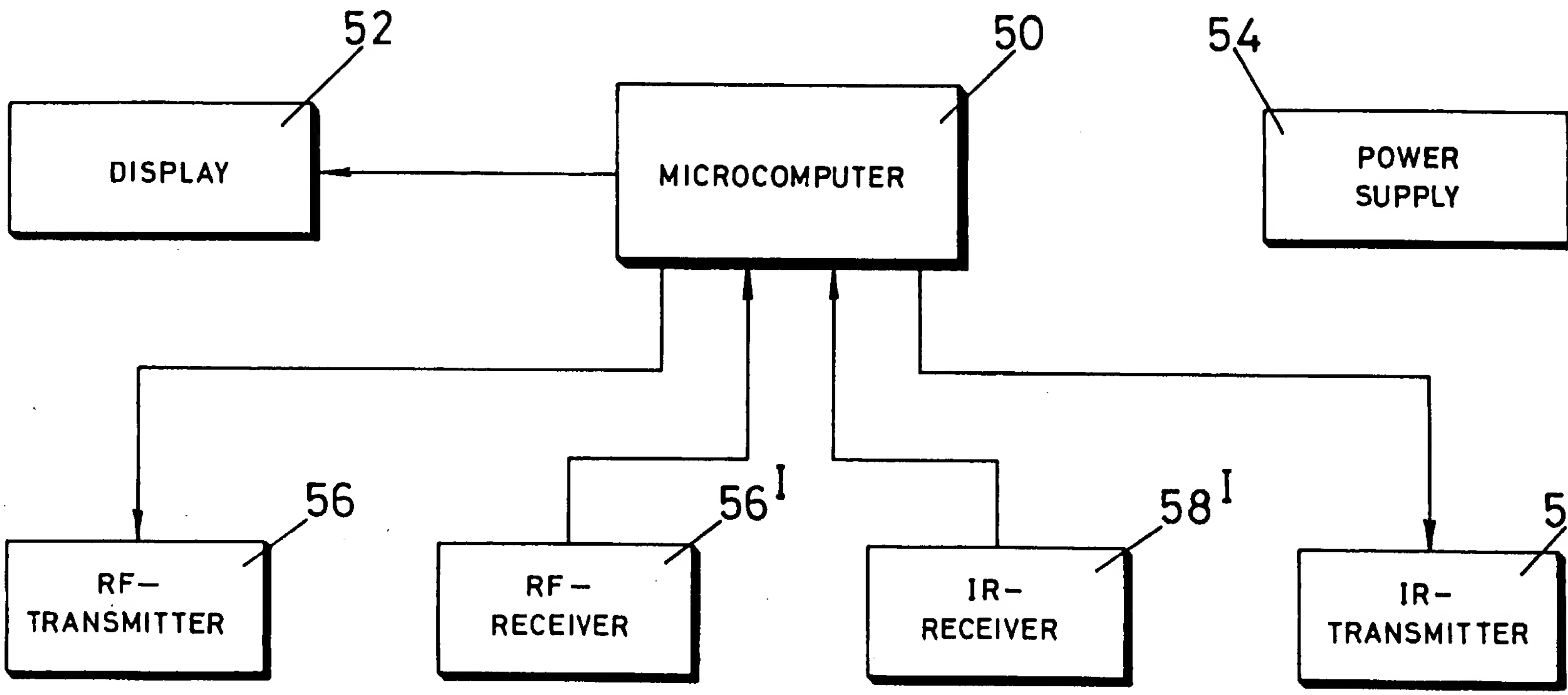

Fig. 4

device at mine

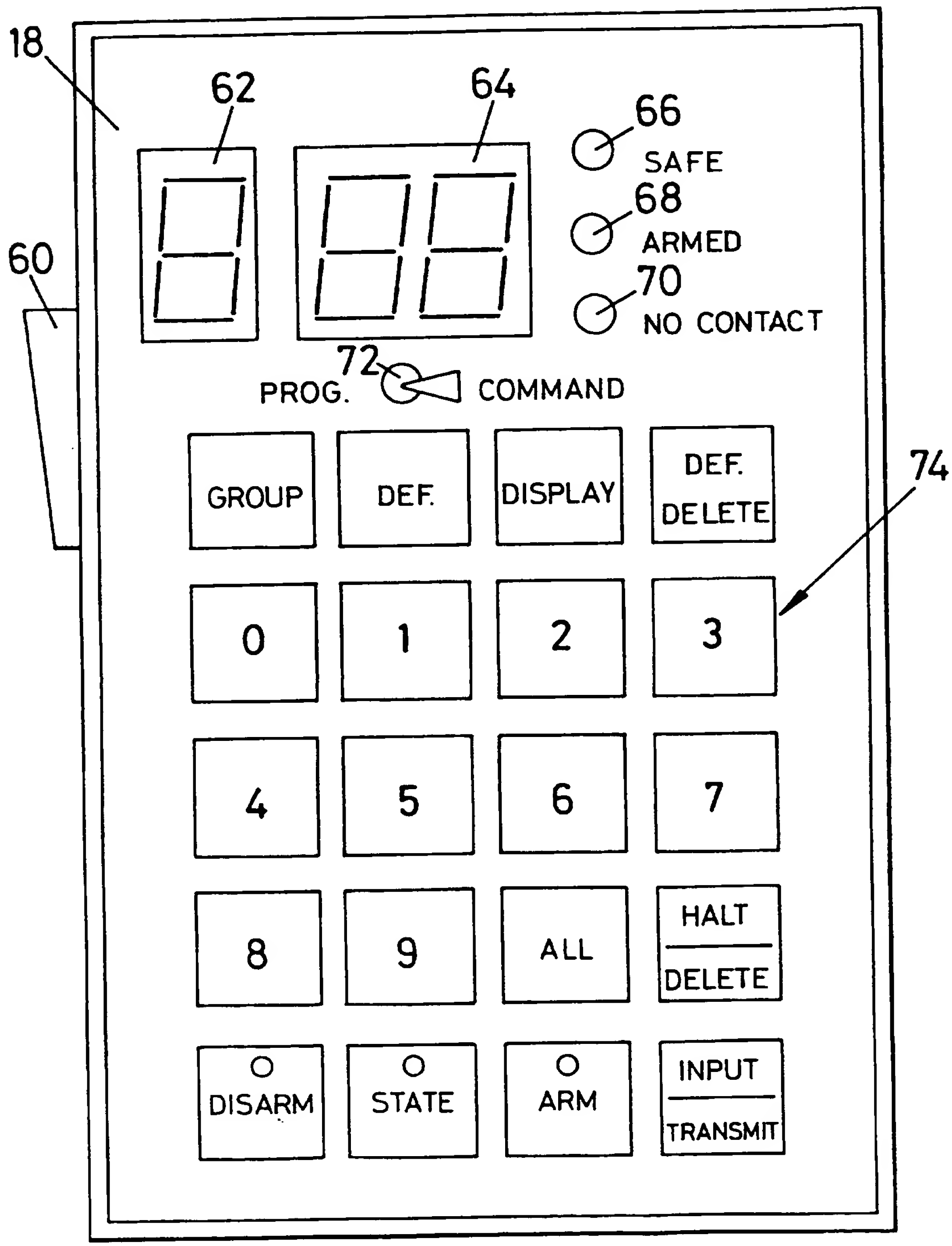
18
62
64
66
SAFE
68
ARMED
70
NO CONTACT
60
72
PROG.
COMMAND
GROUP
DEF.
DISPLAY
DEF.
DELETE
74
0
1
2
3
4
5
6
7
8
9
ALL
HALT
DELETE
DISARM
STATE
ARM
INPUT
TRANSMIT

Fig. 5

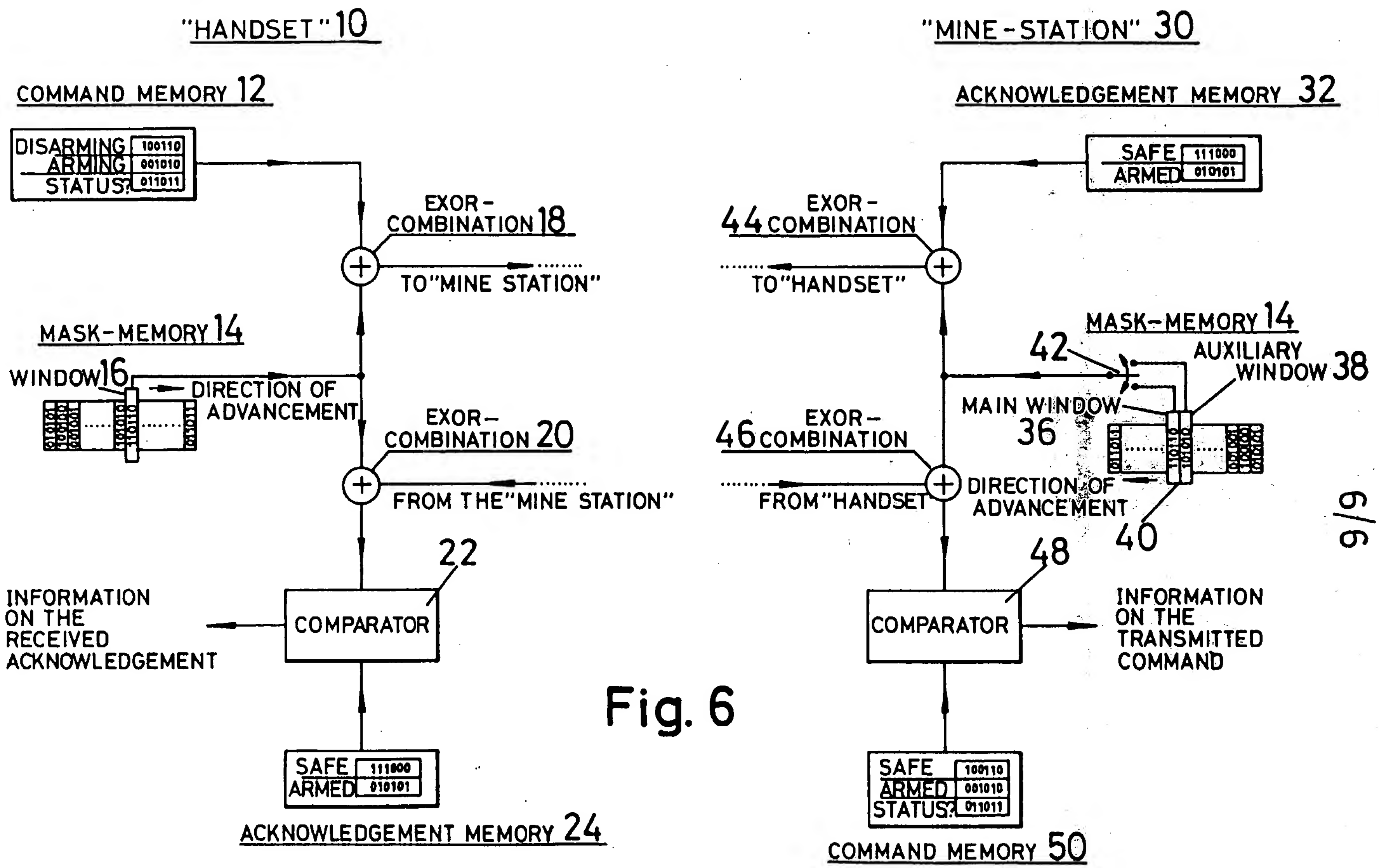
"HANDSET" 10
COMMAND MEMORY 12
DISARMING 100110
ARMING 001010
STATUS? 011011
EXOR-COMBINATION 18
TO "MINE STATION"
MASK-MEMORY 14
WINDOW 16
DIRECTION OF ADVANCEMENT
EXOR-COMBINATION 20
FROM THE "MINE STATION"
22
COMPARATOR
INFORMATION ON THE RECEIVED ACKNOWLEDGEMENT
SAFE 111000
ARMED 010101
ACKNOWLEDGEMENT MEMORY 24
"MINE-STATION" 30
ACKNOWLEDGEMENT MEMORY 32
SAFE 111000
ARMED 010101
44 EXOR-COMBINATION
TO "HANDSET"
MASK-MEMORY 14
42
AUXILIARY WINDOW 38
MAIN WINDOW 36
46 EXOR-COMBINATION
FROM "HANDSET"
DIRECTION OF ADVANCEMENT
40
48
COMPARATOR
INFORMATION ON THE TRANSMITTED COMMAND
SAFE 100110
ARMED 001010
STATUS? 011011
COMMAND MEMORY 50

Fig. 6

2299850

Method and device for remotely actuating mines

The present invention relates to a method for remotely actuating mines in accordance with the generic concept of Patent Claim 1 and to a device for carrying out this method.

From German Patent Specification 977,974 it is known to disarm and thereafter also to rearm a sea mine, if necessary, by wireless remote control, this being done, for example, by means of a low-frequency modulated current flow, generated by a minesweeper, through the surrounding water. Each mine is equipped with a receiver to control the firing mechanism, by means of the received electrical energy and due to the frequency or modulation of the current flow, via a relay into the safe position or into the armed position. In this manner, a minefield can be temporarily controlled to be ineffective for the passage of friendly ships and thereafter armed again. However, an enemy can also receive the information located in the frequency or modulation of the current flow through the water, analyze this information and in turn change the status of the minefield undetectedly in his own interest. The same method could be used in the case of landmines, where appropriate radiowaves are transmitted through the atmosphere. However, this results in the same uncertainties.

A resecurable mine has also been previously proposed (German Patent Application P 35 38 786.6, P 35 45 289.7), in which a securing code is entered in a memory in the mine which is then later compared with a signal

code entered by other means via a code switch or acoustically, a fuse securing device being reset into the secured position only when the two codes correspond.

Apart from the fact that remote actuation over long distances is not possible in this solution, each code convention in advance represents an uncertainty since an enemy can acquire possession of this code. In addition, a manual or an acoustic input of the signal code is not in every case copy- or monitoring-proof.

The present invention therefore has the object of specifying a method for remotely actuating mines which is safe against reconnaissance and deliberate manipulation in every case. This object is achieved in accordance with the method according to the invention, characterized in Patent Claim 1. Further advantageous developments of the method and a device for carrying out the method are to be found in the subclaims.

By using a monitoring-proof separate channel in a preliminary programming phase, it is possible to agree with individual mines specific command and acknowledgement bit patterns which ensure in a subsequent command phase, in which the commands are transmitted via a channel which can be monitored, that communication is only possible between command device and mine. This renders impossible any passive or active impairment of the data transmission between command device and mine by an enemy and accidental or systematic disturbances due to the physical properties of the transmission channel can be prevented by appropriate coding schemes and filters.

Preferably, respective enciphering and deciphering can be performed by superimposing bit patterns generated in a pseudo-random generator on the command and acknowledgement bit patterns.

Preferably both the command transmission and the return acknowledgement message are provided with a monitoring possibility. More particularly, the command and acknowledgement bit patterns are logically combined with stored mask bit patterns during transmission and reception for the purpose of enciphering and deciphering the command and acknowledgement bit patterns.

In the text which follows, the method according to the invention and illustrative embodiments for carrying out this method will be explained with reference to the figures of the attached drawing, in which:

Figure 1 shows a typical application situation for the method according to the invention;

Figure 2 shows the principle of enciphering and deciphering information to be transmitted between a transmitter and a receiver;

Figure 3 shows a block diagram of a handset;

Figure 4 shows a block diagram of a device at the mine;

Figure 5 shows a handset in a topview; and

Figure 6 shows a block diagram of another embodiment of the invention.

According to Figure 1, a number of anti-tank mines 10 to 10^{IV} are installed along a road 12 on which a vehicle 14 approaches. A soldier 16 operates from cover a handset 18 by means of which the mines 10 to 10^{IV} can be, for example, armed individually or in groups, in a manner still to be described in greater detail, if they have been previously appropriately programmed. Whilst the command transmission occurs via a radio frequency (RF) channel which can be monitored, the programming is effected via a directional infrared (IR) channel which is secure against monitoring and interference.

Apart from the monitoring- and interference-proof channel, an enciphering system is additionally used in the programming phase, in which the commands and acknowledgements present in plain text are supplied, according to Figure 2, in the transmitter 20 to a binary encoder 22 which converts the commands and acknowledgements into corresponding redundant bit patterns. Enciphering the corresponding commands and acknowledgements is effected by superimposition of the bit pattern generated in a pseudo-random generator 24 in a binary adder 26. A corresponding method is used during the deciphering in a receiver 28 and this is therefore equipped with the same equipment elements.

According to Figure 3, the handset essentially exhibits the following components:

a microcomputer 30 which is provided in known manner with a central processing unit CPU, a program memory ROM, a working memory RAM and corresponding interfaces and which,

as the central element, controls all other components.
A non-volatile memory 32 in which the commands and acknowledgements agreed between the handset and the mines are stored.
An operating panel 34 via which the "programming" or "remote control" operating mode can be selected in a manner still to be described in greater detail. The "programming" operating mode is used when setting up and activating the mine or mines, during which process commands and acknowledgements are agreed between the handset and the mine or mines. In the "remote control" operating mode, a programmed mine is selected to enter into it a corresponding command.
A display 36 indicates to the operator of the handset the respective number of the mine selected and displays the selected command and operating state of the mine selected.
An analog noise generator 38 is used for initializing a pseudo-random generator, described by means of Figure 2 and implemented by software in the microcomputer in the present case.

A power supply 40 consists of a battery set and is used for cycling and switching the supply voltage of particular assemblies, which can be done via switches operated by the microcomputer 30.
An RF transmitter/receiver 40, 42' is used for radiating and receiving RF signals in the command phase.
An IR transmitter/receiver 44, 44' provides the monitoring-proof channel in the programming phase.

According to Figure 4, each mine also contains a microcomputer 50 which is equipped in accordance with the microcomputer of the command set and is also used for centrally controlling the remaining components.

A display 52 indicates, clearly visible to the eye, the state of the mine, namely whether it is armed or disarmed. A power supply 54 is again used for providing

a supply voltage for the various components. An RF transmitter/receiver device 56, 56' and an IR transmitter/receiver device 58, 58' is again arranged to form the command channel, which can be monitored, and the monitoring-proof programming channel with the corresponding components of the handset.

During the programming of the mine or of a group of mines via the monitoring- and interference-proof IR channel of limited local effect, the commands and acknowledgements required for the later command phase are agreed between the handset (Figure 3) and the mine or mines (Figure 4) which amounts to an initial loading of the deciphering system of the mine. Since these bit patterns are only defined in the programming phase, a maximum of security against deliberate enemy attempts at influencing is provided later.

The programming of a mine occurs as follows:

1. The handset generates, on a pseudo-random basis, command and acknowledgement bit patterns, provides these with redundancy and transmits them to the mine via the IR channel.
2. The mine to be programmed receives these bit patterns, checks their correctness from the redundancy and acknowledges reception by sending out plant-defined bit patterns. These acknowledgements, such as, for example, "mine programmed" or "mine not programmed", however, only apply during the programming phase.
3. Once the mine has been successfully programmed, the handset indicates the mine state "safe".
4. If errors have occurred during the programming, the handset repeats the programming attempt. It continues this cycle until the programming of the mine is indicated as successful or it must be considered to be defective after a limited number of attempts.
5. If the programming of the mine was not successful,

the mine does not acknowledge the programming or answers with "not programmed", the handset indicates the mine state "no contact".

6. After the successful or unsuccessful programming of a mine, the respective mine state "safe" or "no contact" is still indicated for a certain time. The mine number counter is subsequently incremented and the handset is ready for programming further mines.

After the successful programming of one or several mines, the handset must be switched to the "remote control" operating mode, that is to say into the command phase. The mines can now only be addressed via the RF radio channel which can be monitored. In this command phase, an operator of the handset can remotely control individual mines or even entire mine groups. For this purpose, he must select the required mine or the mine group and the command to be executed. In the command phase, a mine is remotely controlled as follows:

1. The handset transmits the redundancy-equipped command bit pattern via the RF channel in accordance with the selected mine and the required command.
2. All programmed mines receive this bit pattern and check its correctness from the redundancy. However, this command has only been agreed with a single mine or a single group of mines during the programming phase.
3. If the checked bit pattern has been recognized as command by the mine selected, it executes the predetermined instruction and acknowledges execution by sending out its new "safe" or "armed" state via the RF channel.
4. If the status transmitted by the mine is received by the handset and is graded as valid after the redundancy check, this mine status is displayed on the display of the handset.

5. If errors have occurred during the remote control, that is to say if, for example, there was interference on the RF channel and the command was wrongly received, the handset repeats the remote control attempt. It continues this cycle until a valid mine status has been detected or the connection to this mine must be considered to be disturbed after a limited number of attempts.
6. If the remote control attempt was not successful, the handset indicates the "no contact" state of the mine.

The handset can exhibit, for example, the construction shown in Figure 5. A key 60 arranged on the side can be used for switching on the handset. The microcomputer contained in the handset 18 automatically switches off the power supply if there has been no operator input, such as, for example, selection of a mine, communication with a mine and so forth within a certain time after the switch-on key 60 has been operated. A display panel is provided in the upper quarter of the handset 18, a first single-digit LCD display 62 being used for indicating a mine group number and a two-digit LCD display 64 being used for indicating the number of a selected mine. Three light-emitting diodes 66, 68 and 70 arranged adjacently above one another are used for representing the mine state which can be predetermined by "safe", "armed" and "no contact". Below the display panel, there is a toggle switch 72 by means of which the programming phase or the command phase can be selected. Below this toggle switch, there is an operating keypanel which comprises ten keys (0-9) for entering a mine number, one key (all) for selecting all programmed mines, one key (group) for selecting a mine group, one key (DEF) for defining a mine group, one key (DEF delete) for deleting group allocations, one key (display) for displaying the group association of mines, three command keys (disarm, arm, state), one key

(hold/delete) for interrupting the command execution and for correcting an input and one key (enter/transmit) for terminating an input and for starting the data transmission from the handset to the mine.

Referring now to Figure 6, a description will now be given of a further development which aims to simplify the latter technique. In this connection, the device shows the construction of a handset 10 as operating station and of a mine station 30 which can be provided by a single mine or a group of mines to be actuated in the same manner.

The handset 10 has a command memory 12 in which particular commands are stored by means of corresponding bit patterns. Furthermore, the handset 10 exhibits an acknowledgement memory 24 in which particular acknowledgements are stored by means of corresponding bit patterns. Finally, the handset 10 exhibits a mask memory 14 which is loaded with randomly generated bit patterns in memory rows a_1 to a_n. A window 16 is used for reading out in each case one row a_1 of the mask memory 14 and is moved step by step over the mask memory 14 in the direction indicated by the arrow. When a command is transmitted, an exclusive OR gate 18 logically combines the command bit pattern stored in the command memory 12 with the mask bit pattern of the mask memory 14 underneath the window 16. Similarly, an exclusive OR gate 20 logically combines the acknowledgement bit pattern with the mask bit pattern of the mask memory 14 underneath the window 16 when an acknowledgement is received. The deciphered acknowledgement bit pattern is compared with the acknowledgement bit patterns stored in the acknowledgement memory 24 in a comparator 22.

The command bit patterns, acknowledgement bit patterns and mask bit patterns allocated to a mine station 30 are generated on a pseudo-random basis in the handset 10 and transmitted to the mine station 30 via a monitoring-proof channel so that they exist identically in the handset 10 and in the mine station 30. These bit patterns are loaded in a programming phase which precedes a

command phase, and a radio channel which can be monitored can then be used in the command phase.

In correspondence with the handset 10, the mine station 30 has an acknowledgement memory 32, a mask memory 34 and a command memory 50 and two exclusive OR gates 44 and 46 and a comparator 48. In this arrangement, however, the comparator 48 is used for comparing the deciphered command with the command stored in a command memory 50. In deviation from the handset 10, the mine station 30 has a dual window 40, consisting of a main window 36 and an auxiliary window 38, for sampling the mask memory 34. A switch 42 allows the mask bit pattern underneath the main or underneath the auxiliary window 36 or 38, respectively, to be optionally used for an exclusive OR (EOR) combination.

In principle, it is sufficient to agree three commands and two acknowledgements, namely the commands for "disarming", "arming" and "status?" and the acknowledgements "safe" and "armed", in which arrangement the bit patterns of all commands and acknowledgements differ from one another in as many bit positions as possible and the commands and acknowledgements also must be different with respect to their bit patterns. It should also be pointed out that different commands and acknowledgements are agreed for each mine or group of mines so that individual influencing and acknowledgement is possible.

In the text which follows, the enciphering and deciphering will be explained with reference to a command transmission. For example, the mine is to be armed by the command "arming". According to the single figure, in this case, the bit pattern 001010 is subjected to an EOR operation with the mask bit pattern 110110 in the handset 10 which leads to the enciphered transmitted arming command 111100. This command is transmitted by a

radio link to be received and deciphered in the mine station 30 where it is again subjected to an EOR operation with the same mask bit pattern 110110 located underneath the main window 36, for deciphering purposes, which leads to the deciphered command bit pattern 001010. The correctness and validity of the command received can be established by a comparison in the comparator 48 with the stored command set and a corresponding "armed" acknowledgement can be triggered and sent back enciphered in the same manner.

Coding of the commands and acknowledgements by means of six bits only represents a simplified illustrative embodiment. The probability that a command becomes detectable with a wrong mask with a randomly generated content of the memories becomes less if a greater command, acknowledgement and mask length is selected. If, for example, a coding length of 48 bits is selected, a theoretical error probability of

$$\frac{1}{2^{48}} \approx 3,6 \cdot 10^{-15}$$

is obtained. The operation of the device shown in the figure, and thus the method according to the invention, will be explained in the text which follows with reference to three case examples:

<u>Case 1: No interference on the forward and back channel</u>

A command from the command set of the command memory 12 is logically combined with row a_1 underneath the window 16 of the mask memory 14 via the gate 18 and transmitted to the mine station 30 via the transmission channel. In the mine station 30, the incoming command is logically combined via the gate 46 with the mask bit pattern read out in row a_1 by the main window 36, as a result of which the command bit pattern is obtained again in the manner already shown. The comparator 48 compares

this command bit pattern with the command set in the command memory 50 and, in the case of correspondence, the corresponding acknowledgement bit pattern is logically combined via the gate 44 with the mask bit pattern in row a_1 underneath the main window 36 of the mask memory 34. The acknowledgement signal enciphered in this manner is sent back to the handset 10 via the back channel. The mine station 30 increments the dual window 40 so that the main window 36 is located above row a_{i+1} and the auxiliary window 38 is located above row a_1. When the valid acknowledgement arrives in the handset 10, the window 16 is also incremented from row a_1 to row a_{i+1}. After that, a further command can be issued. The process is then correspondingly repeated with the mask bit patterns in rows a_{i+1}, a_{i+2} and so forth.

<u>Case 2: Disturbances in the forward channel</u>

This case is relatively simple since a command not arriving or a command arriving with errors does not have any effect in the mine station 30. As a result, an acknowledgement is also lacking. According to the convention, the handset 10 does not increment the window 16 sampling the mask memory 14 because of the lacking acknowledgement and the mine station 30 also does not increment the dual window 40 as long as no valid command is detected. In this manner, synchronism between handset 10 and mine station 30 is maintained.

<u>Case 3: Interference in the back channel</u>

A command logically combined with a mask bit pattern in row a_1 of the mask memory 14 in the handset 10 is received in the mine station 30 and there causes, as described in case 1, the acknowledgement to be produced and the dual window 40 to be incremented in the mask memory 34. The mask bit pattern a_1 then appears in the auxiliary window 38 whereas the main window 36 contains the mask

bit pattern located in row $a_i + 1$. Due to the assumed interference in the back channel, the handset 10 does not receive a valid acknowledgement so that the window 16 is not incremented in the mask memory 14 of the handset 10. If then a further command is issued form the handset 10, it will still be logically combined with the bit pattern in row a_1. However, the mine station 30 can then establish that it can only detect a logical command if it combines it with the content of the auxiliary window 38 because the main window 36 is already above row $a_i + 1$. The mine station 30 responds by executing the command and providing a status return message in the form of the acknowledgement. However, it does not increment its dual window 40. If the handset 10 is now capable of receiving the acknowledgement, the window 16 is also incremented there in the mask memory 14. With the next command, the mine station 30 will retrieve the command bit pattern again with the mask from the main window 36 which then leads to the dual window 40 being incremented. Accordingly, the dual window 40 in the mine station 30 is incremented only if the command bit pattern can be retrieved by means of the mask from the main window 36.

It is obvious that all memories existing in the figure shown and the exclusive OR gates and the comparator are preferably implemented by means of a microcomputer which can also make the abovementioned decisions for incrementing the windows.

Patent claims:

1. Method for remotely actuating (disarming, arming) mines by wireless remote control in a command phase, characterized in that after the installation and before the remote actuation of each mine, command and acknowledgement bit patterns are agreed in a programming phase with this mine or with a group of mines via a monitoring- and interference-proof channel of limited local effect, so that response is obtained in the command phase only to commands agreed in the programming phase.

2. Method according to Claim 1, characterized by a programming arrangement via an infrared (IR) channel.

3. Method according to Claim 1, characterized in that the command and acknowledgement bit patterns are generated on a pseudo-random basis and are equipped with redundancy.

4. Method according to Claim 1, characterized in that the same command and acknowledgement bit patterns are agreed for a group of mines.

5. Device for carrying out the method according to one of Claims 1 to 4, characterized by in each case one microcomputer (30, 50) and one RF transmitting/receiving device (42, 42'; 56, 56') and an IR transmitting/receiving device (44, 44'; 58, 58') in a handset (18) and in the mine (10 - 10^{IV}).

6. Device according to Claim 5, characterized by a non-volatile memory (32) in the handset (18) for the storing of commands and acknowledgements agreed per mine or mine group.

7. Device according to Claim 6, characterized by a noise generator (36) for initializing pseudo-random generators (24, 24') arranged in the handset and in the mine.

8. Device according to Claim 7, characterized by display devices (36, 52) for indicating at the handset

the number of the selected mine or mine group, the required command and the operating state of the mine and, at the mine, its operating state.

9. Method according to any of claims 1-4 characterized in that the command and acknowledgement bit patterns are logically combined with stored mask bit patterns transmission and reception for the purpose of enciphering and deciphering the command and acknowledgement bit patterns.

10. Method according to Claim 9, characterized in that the same mask bit patterns are used in the operating station and the mine.

11. Method according to Claim 9, characterized by a time-synchronous sampling of the mask bit patterns.

12. Method according to one of Claims 9 to 11 characterized in that the logical combination is predetermined by an exclusive OR combination.

13. Method according to Claim 12, characterized in that the exclusive OR operation is performed with the same mask bit pattern in each case during transmission and during reception of a command or acknowledgement bit pattern.

14. Method according to Claim 13, characterized in that the time-synchronous incrementing of the mask bit pattern in the operating station is performed only if a valid acknowledgement bit pattern is received after transmission of a command bit pattern.

15. Method according to Claim 13, characterized in that the time-synchronous incrementing of the mask bit pattern in the mine is performed only if a valid command bit pattern is received the representation of which differs from the representation of the previously received

command bit pattern.

16. Method according to Claim 15, characterized in that two adjacently located mask bit patterns are used in the mine, that on reception of a valid command bit pattern in the mine, the adjacently located mask bit patterns are incremented, that on reception of an invalid acknowledgement bit pattern in the operating station, the mask bit pattern is not displaced in the latter so that on transmission of the next command bit pattern on the transmit side the logical combination is effected with the same mask bit pattern and that on reception in the mine the mask bit pattern displaced back of the adjacently located mask bit patterns is used for the logical combination.

17. Method according to any of Claims 9 to 16 characterized in that the command, acknowledgement and mask bit patterns are loaded on a pseudo-random basis.

18. Device for carrying out the method according to one of Claims 9 to 17, characterized by in each case one command memory (12, 50) and acknowledgement memory (24, 32) and a mask memory (14, 34) in the operating station (10) and in the mine (30), time-synchronously moved windows (16, 40) for reading-out in each case one row (a_1) of the mask memories (14, 34), and logical combining elements (18, 20; 44, 46) for enciphering or deciphering, respectively, the transmitted or received, respectively, command bit patterns and acknowledgement bit patterns.

19. Device according to Claim 18, characterized by comparators (22, 48) in the operating station (10) and the mine (30) for comparing the received deciphered command bit pattern with command bit patterns in the command memory (50) of the mine (30) and for comparing the received deciphered acknowledgement bit patterns with acknowledgement bit patterns in the acknowledgement memory

(24) of the operating station (10).

20. Device according to Claim 18, characterized in that the window (40) in the mine (30) consists of a dual window extending over two rows of the mask memory (34), the main window (36) of which is incremented in synchronism with the window of the operating station (10) and the auxiliary window (38) of which is displaced back by one row.

21. A method according to any of claims 1-4 and substantially as herein described with reference to Figures 1-5 of the accompanying drawing.

22. A method according to any of claims 9-17 and substantially as herein described with reference to Figure 6 of the accompanying drawing.

23. A device according to any of claims 6-8 and substantially as herein described with reference to Figures 1-5 of the accompanying drawing.

24. A device according to any of claims 18-20 and substantially as herein described with reference to Figure 6 of the accompanying drawing.

Amendments to the claims have been filed as follows

1. Method for remotely actuating (disarming, arming) mines by RF remote control in a command phase, characterized in that after the installation and before the remote actuation of each mine, command and acknowledgement bit patterns are agreed in a programming phase with this mine or with a group of mines via an infrared (IR) channel of limited local effect, so that response is obtained in the command phase only to commands agreed in the programming phase.

2. Method according to Claim 1, characterized in that the command and acknowledgement bit patterns are generated on a pseudo-random basis and are equipped with redundancy.

3. Method according to Claim 1, characterized in that the same command and acknowledgement bit patterns are agreed for a group of mines.

4. Device for carrying out the method according to any of Claims 1 to 3, characterized in that the device includes a microcomputer (30, 50), a RF transmitting/receiving device (42, 42'; 56, 56') and an IR transmitting/receiving device (44, 44'; 58, 58') in a handset (18) and in the mine (10 - 10^{IV}), whereby the RF device is used in the command phase and the IR device is used in the programming phase.

5. Device according to Claim 4, characterized by a non-volatile memory (32) in the handset (18) for the storing of commands and acknowledgements agreed per mine or mine group.

6. Device according to Claim 5, characterized by a noise generator (36) for initializing pseudo-random generators (24, 24') arranged in the handset.

7. Device according to Claim 7, characterized by display devices (36, 52) for indicating at the handset the number of the selected mine or mine group, the required command and

the operating state of the mine and, at the mine, its operating state.

8. Method according to any of Claims 1-4 characterized in that the command and acknowledgement bit patterns are logically combined with stored mask bit patterns transmission and reception for the purpose of enciphering and deciphering the command and acknowledgement bit patterns.

9. Method according to Claim 8, characterized in that the same mask bit patterns are used in the operating station and the mine.

10. Method according to Claims 8 or 9, characterized in that the logical combination is predetermined by an exclusive OR combination.

11. Method according to Claim 10, characterized in that the exclusive OR operation is performed with the same mask bit pattern in each case during transmission and during reception of a command or acknowledgement bit pattern.

12. Method according to any of Claims 8-11, characterized by sampling and incrementing of the mask bit patterns.

13. Method according to Claim 12, characterized in that the incrementing of the mask bit pattern in the operating station is performed only if a valid acknowledgement bit pattern is received after transmission of a command bit pattern.

14. Method according to Claim 12, characterized in that the incrementing of the mask bit pattern in the mine is performed only if a valid command bit pattern is received the representation of which differs from the representation of the previously received command bit pattern.

15. Method according to Claim 14, characterized in that two adjacently located mask bit patterns are used in the mine, that on reception of a valid command bit pattern in the mine, the adjacently located mask bit patterns are incremented, that on reception of an invalid acknowledgement bit pattern in the operating station, the mask bit pattern is not displaced in the latter so that on transmission of the next command bit pattern on the transmit side the logical combination is effected with the same mask bit pattern and that on reception in the mine the mask bit pattern displaced back of the adjacently located mask bit patterns is used for the logical combination.

16. Method according to any of Claims 8-15, characterized in that the command, acknowledgement and mask bit patterns are loaded on a pseudo-random basis.

17. Device for carrying out the method according to any of Claims 8-16, characterized by in each case one command memory (12, 50) and acknowledgement memory (24, 32) and a mask memory (14, 34) in the operating station (10) and in the mine (30), moved windows (16, 40) for reading-out in each case one row (a_1) of the mask memories (14, 34), and logical combining elements (18, 20; 44, 46) for enciphering or deciphering, respectively, the transmitted or received, respectively, command bit patterns and acknowledgement bit patterns.

18. Device according to Claim 17, characterized by comparators (22, 48) in the operating station (10) and the mine (30) for comparing the received deciphered command bit pattern with command bit patterns in the command memory (50) of the mine (30) and for comparing the received deciphered acknowledgement bit patterns with acknowledgement bit patterns in the acknowledgement memory (24) of the operating station (10).

19. Device according to Claim 17, characterized in that the

window (40) in the mine (30) consists of a dual window extending over two rows of the mask memory (34), the main window (36) of which is incremented with the window of the operating station (10) and the auxiliary window (38) of which is displaced back by one row with respect to the main window.

20. A method according to any of Claims 1-3 and substantially as herein described with reference to Figures 1-5 of the accompanying Drawing.

21. A method according to any of Claims 8-16 and substantially as herein described with reference to Figure 6 of the accompanying Drawing.

22. A device according to any of Claims 5-7 and substantially as herein described with reference to Figures 1-5 of the accompanying Drawing.

23. A device according to any of Claims 17-19 and substantially as herein described with reference to Figure 6 of the accompanying Drawing.

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PATENTS ACT 1977
EXAMINER'S REPORT TO THE COMPTROLLER UNDER SECTION 17(5)
(The Search Report)

Application No.

8815971

FIELD OF SEARCH: The search has been conducted through the relevant published UK patent specifications and applications, a applications published under the European Patent Convention and the Patent Co-operation Treaty (and such other documents as n be mentioned below) in the following subject-matter areas:-

UK Classification F3A (A12; ADC; ADD; ADN; ADP; AEA; AEB; ABB; ABC; AC)

(Collections other than UK, EP & PCT:)

DOCUMENTS IDENTIFIED BY THE EXAMINER (NB In accordance with Section 17(5), the list of documents below may inclu only those considered by the examiner to be the most relevant of those lying within the field (and extent) of search)

Category	Identity of document and relevant passages	Relevant to claim(s
	None	All

CATEGORY OF CITED DOCUMENTS

- X relevant if taken alone
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Search examiner J Betts

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